THE EFFECTS OF ORBITAL DRIFT ON SPECTRAL RADIANCES FROM HIRS OBSERVATIONS AND GFDL CLIMATE MODEL SIMULATIONS

Darren L. Jackson[1] and Brian J. Soden[2]

[1]Cooperative Institute for Research in Environmental Sciences, [2]NOAA/Geophysical Dynamic Fluids Laboratory

Darren.L.Jackson@noaa.gov, (303) 497-6180

http://www.etl.noaa.gov/satres

INTRODUCTION

- Recent ERBE observations indicate increased long-wave emission at the top of the atmosphere which conflict with operational products derived from TOVS that show no such trend.

- High-quality HIRS data suitable for long-term climate studies first requires proper characterization of the diurnal sampling drift caused by changes in the equatorial crossing time of the NOAA polar orbiting satellites.

- GFDL climate model simulations and geostationary data used to identify and remove HIRS diurnal sampling bias.

THE SAMPLING PROBLEM

- The HIRS instruments have ridden aboard 12 different NOAA polar-orbiting satellites over the past 25 years. Unfortunately some satellites drifted significantly away from their original local crossing time so that the satellite samples the earth at varying diurnal times.

- Afternoon satellites (2pm LST) have a rate of drift much greater than the morning satellites (8 am LST) thus creating a more significant sampling error for these satellites.

- Diurnal sampling bias is largest for surface-sensing channels where dirunal variations are the largest.

HIRS DATA USED IN THIS STUDY

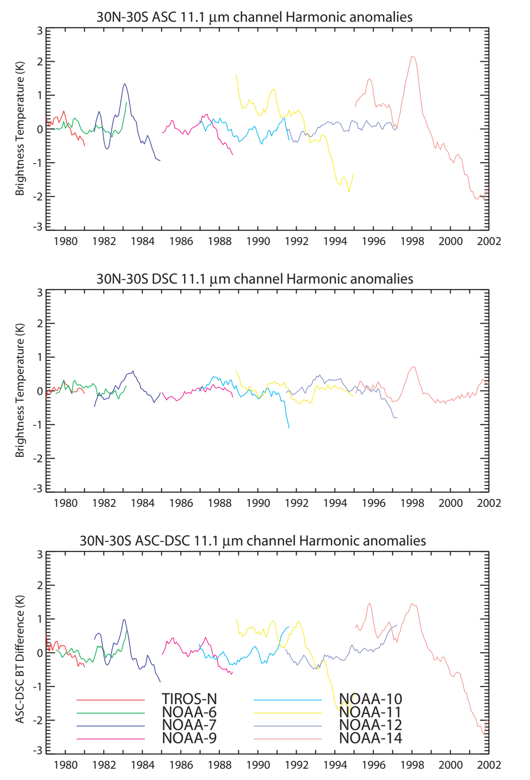
NOAA Satellite	Time Period	Initial Ascending Crossing Time
TIROS-N	11/1978 - 1/1981	1500 LST (a)
NOAA-6	7/1979 - 3/1983	1930 LST (m)
NOAA-7	7/1981 - 1/1985	1430 LST (a)
NOAA-9	1/1985 - 9/1988	1420 LST (a)
NOAA-10	12/1986 - 8/1991	1930 LST (m)
NOAA-11	11/1988 - 12/1994	1330 LST (a)
NOAA-12	6/1991 - 3/1997	1930 LST (m)
NOAA-14	1/1995 - 12/2001	1330 LST (a)

IDENTIFYING THE DIURNAL BIAS

- All-sky HIRS 1b data gridded onto 2.5^0 monthly grids.
- Ascending and descending orbits averaged separately.
- Only average 6 scan positions closest to nadir to eliminate limb effects.
- Only used HIRS/2 data. Did not process NOAA-8 due to short instrument life.
- Anomalies constructed by subtracting first three harmonics.
- GFDL 3-hourly data were used to construct monthly grid anomalies of the entire diurnal cycle and the HIRS-sampling of the diurnal cycle.
- One year of geostationary 3-hourly data also used for verification of diurnal bias.

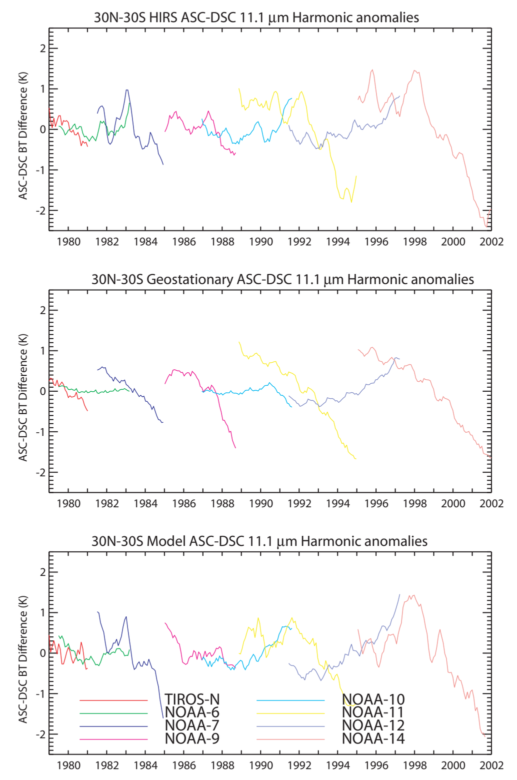
The Observed Bias

- Ascending and descending orbit time series of HIRS 11.1 micron channel indicate significant drift of afternoon satellites.



The Modeled Bias

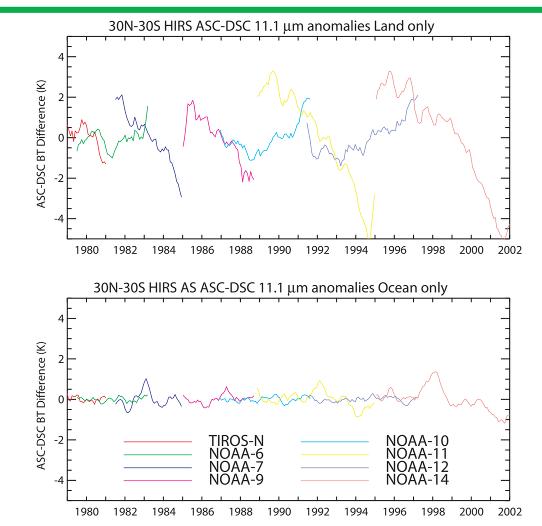
- Differences between ascending and descending orbits for geostationary and model-simulated HIRS 11.1 micron data indicate similar drift of afternoon satellites.



Land vs. Ocean

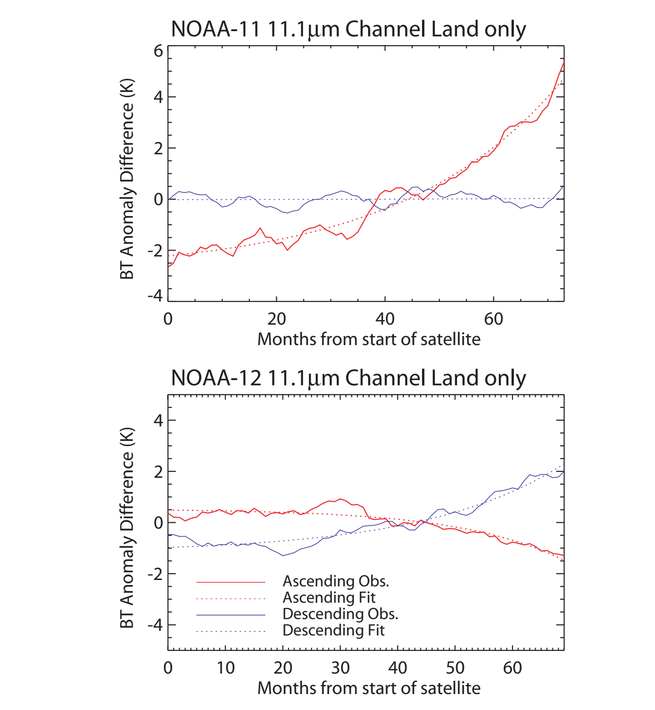
- Land regions show a much larger diurnal bias than oceanic regions.

- Diurnal correction requires accounting for surface type.



CORRECTION METHOD

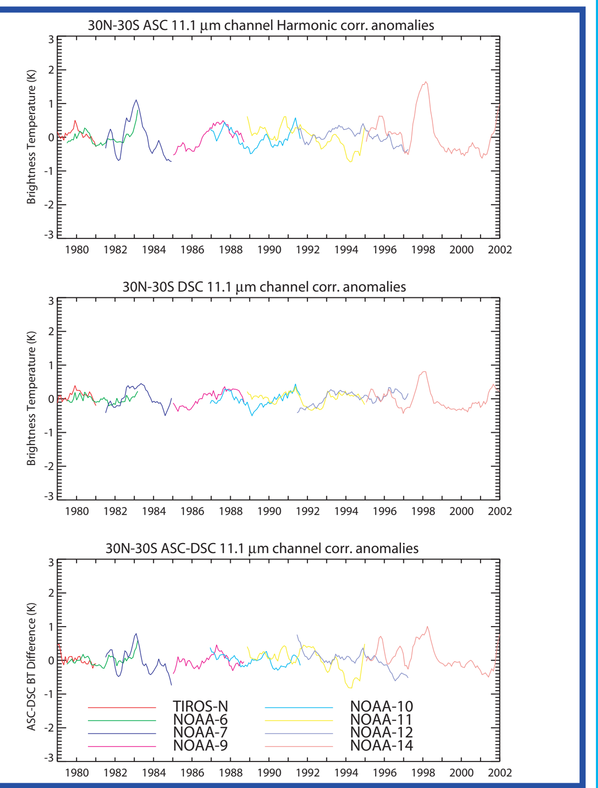
- Corrections developed by fitting the difference between the ascending/descending model anomaly field and the total model anomaly field.
- Correction function of satellite, channel, latitude band, land/ocean.
- Figure gives example of correction for two NOAA-11 and -12.



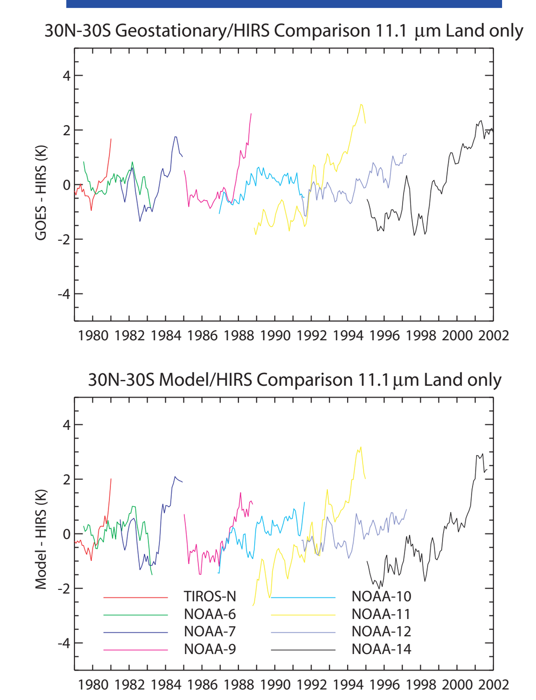
APPLY CORRECTION

- Large drift found for NOAA-11 and -14 has been removed.

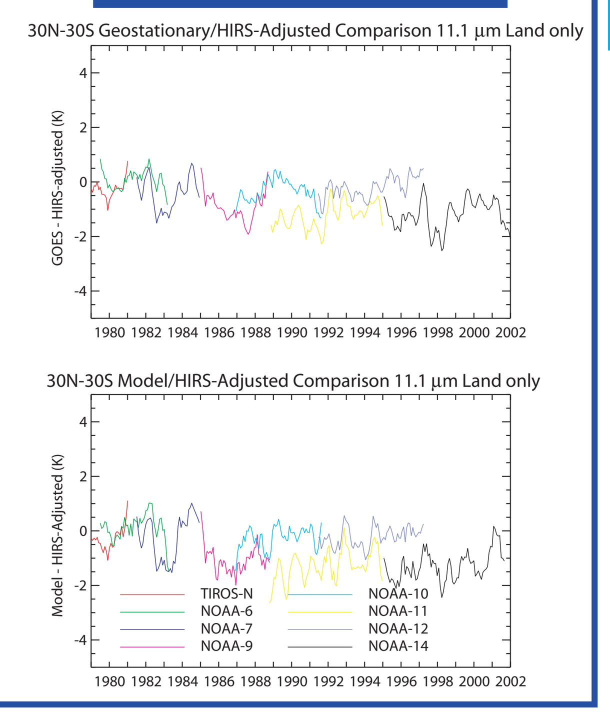
- Interannual variations have been preserved as is seen with NOAA-14 during 1998 El Niño event.



Before Correction

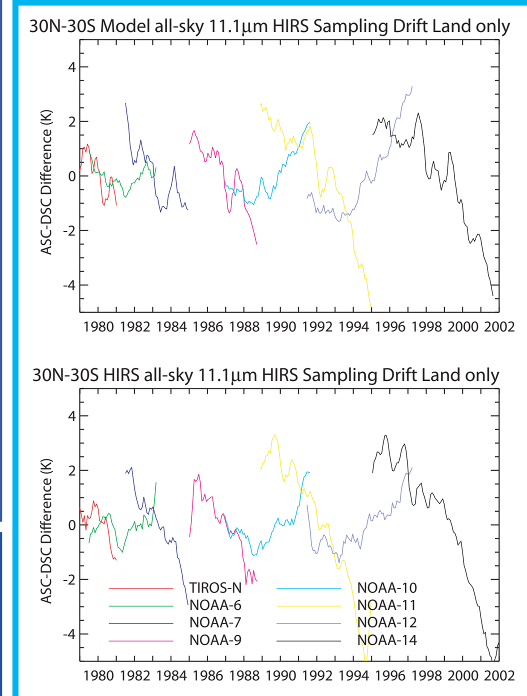


After Correction

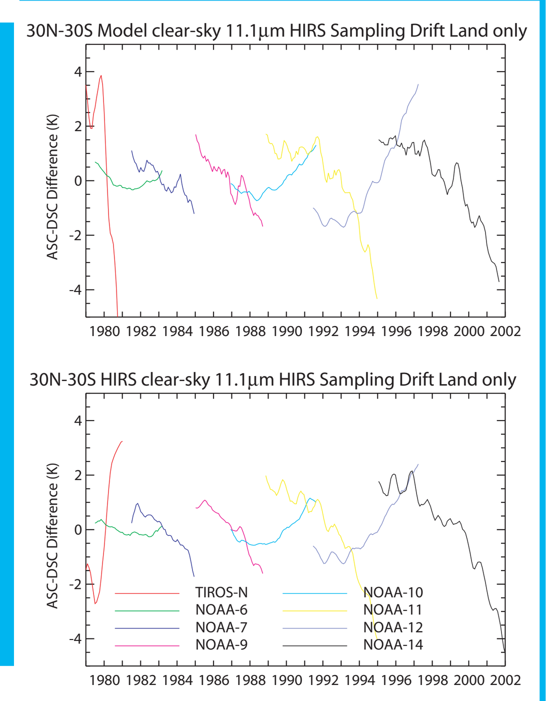


CLEAR-SKY COMPARISON

ALL-SKY 11.1 μm



CLEAR-SKY 11.1 μm

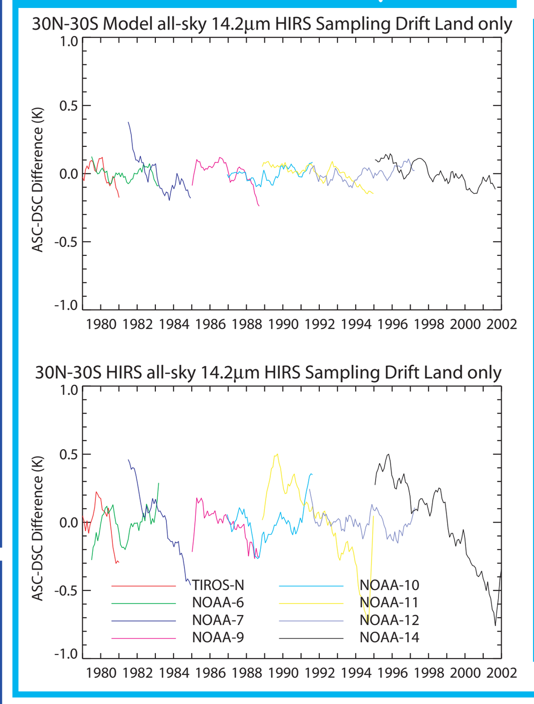


- Diurnal sampling drift for clear-sky and all-sky data show similar trend.

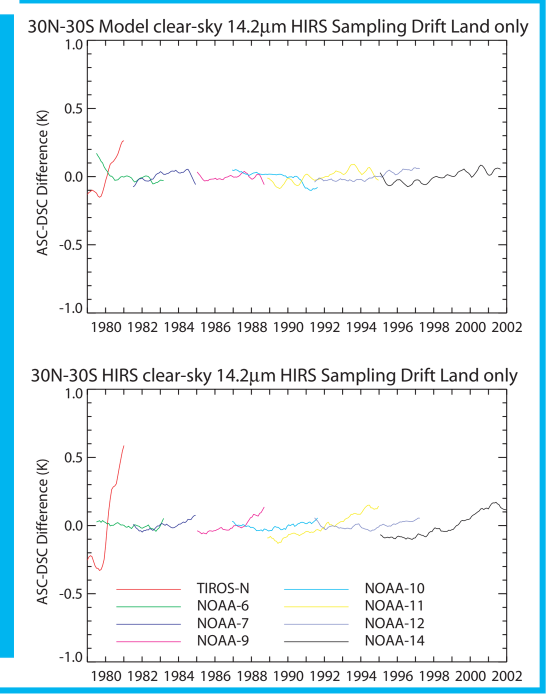
- The sampling drift between HIRS and model show similar trend.

- Excluding clouds in surface channel data has little effect on diurnal bias

ALL-SKY 14.2 μm



CLEAR-SKY 14.2 μm



- Magnitude of diurnal sampling bias small in upper troposphere.

- Model sampling bias smaller than HIRS observed bias.

- Clear-sky and all-sky diurnal bias show opposite trend.

CONCLUSIONS

- The effects of diurnal sampling bias are identified in HIRS data.
- GFDL model and geostationary data confirm HIRS observed bias.
- Model simulations can be used to remove diurnal sampling bias.
- Sampling bias is most prominent over land.
- Sampling bias is identified in both all-sky and clear-sky data.
- Upper tropospheric temperature channels are sensitive to sampling bias.
- Intercalibration is next step toward using HIRS data for climate energy budget studies.